Royal Netherlands
Meteorological Institute
Ministry of Transport,
Public Works and Water Management

Effect of soil initialization on seasonal forecast skill 2000-2010

B. van den Hurk, G. Balsamo, F. Doblas-Reyes,
S. Seneviratne and F. Vitart

Royal Netherlands Meteorological Institute. PO Box 201, 3730 AE De Bilt, The Netherlands, E-mail: hurkvd@knmi.nl

Using realistic initial soil data for 1986-1995, the Global Land Atmosphere Coupling Experiment Phase 2 (GLACE2) showed little improvements of forecasts of T2m and precipitation outside the US. Here we explore with the ECMWF forecasting system IFS whether the GLACE2 set-up generates soil related seasonal predictability for a later period (2000 – 2010), including some major heatwave events in e.g. Russia (2010).

References

Koster, RD et al (2010): The Contribution of Land Surface Initialization to Subseasonal Forecast Skill: First Results from the GLACE-2 Project; Geophys. Res. Lett., 2010, 37, L02402.

Koster, RD et al (2011): The Second Phase of the Global Land-Atmosphere Coupling Experiment: Soil Moisture Contributions to Subseasonal Forecast Skill; J.Hydrometeorol doi: 10.1175/2011JHM1365.1

Van den Hurk, BJJM et al (2010): Soil moisture effects on seasonal temperature and precipitation forecast scores in Europe; Clim. Dyn., 2010, doi:10.1007/s00382-010-0956-2.

1. Set-up

Series 1 experiments used initial soil moisture for all 10 members from offline land surface model simulations driven by ERAint (corrected with GPCP precipitation). **Series 2** runs used random initial soil moisture for each member. An example of simulated soil moisture for the 2010 Russia heatwave area is shown in Fig 1.

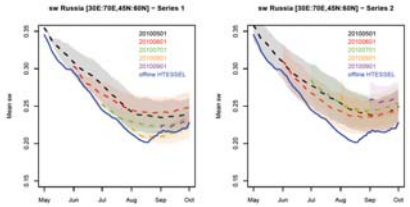
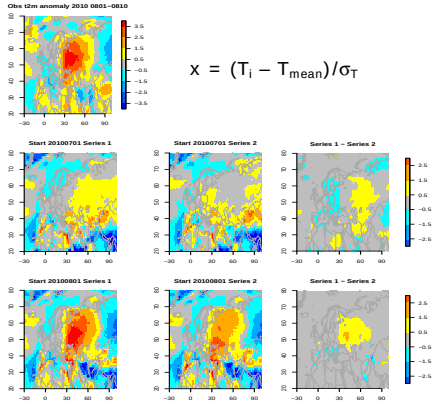


Figure 1: Simulated soil moisture ± 1 ensemble std for the Russia heatwave area. Experiments started on May 1., Jun 1., Jul 1., Aug 1., and Sep 1. and lasted until Oct 1. 2000-2010.

2. Russian heatwave

Fig 2 shows the observed and simulated T2m anomaly between 1 and 10 Aug 2010. A hint for higher temperatures is visible in Series 1 forecasts starting 1 Jul. Forecasts of 1 Aug are improved in Series 1.



$$x = (T_i - T_{mean})/\sigma_T$$

Figure 2: Normalized T2m anomaly (relative to 1989-2010) in ERAint (top panel) and Series 1 & 2 forecasts of 1 Jul and 1 Aug 2010.

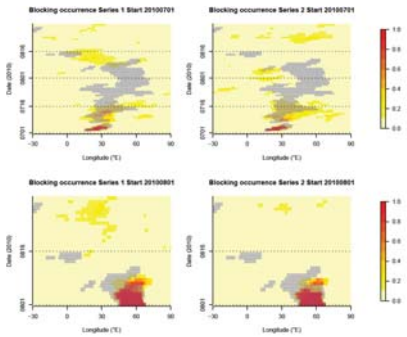


Figure 3: Blocking index from ERAint (dark shading) and the fraction of members in Series 1 (left) and 2 (right) for 2 forecast start dates (colors).

The Series 1 forecasts have no clear beneficial impact on the simulation of blocked atmospheric flows in the Russian heatwave event (Fig 3).

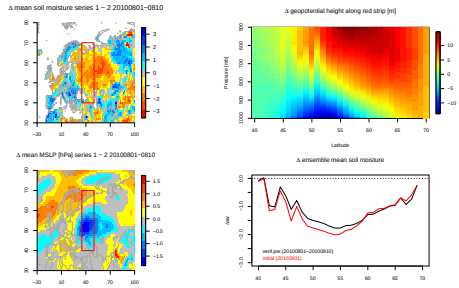


Figure 4: Difference in Series 1 – Series 2 forecasts for 1-10 Aug 2010. Shown are mean normalized soil moisture (top left) and mean MSLP (bottom left), and cross sections of geopotential height and initial & mean soil moisture, zonally averaged over the red box.

For the Russian heatwave event, short range Series 1 forecasts generate a surface heat low over the dry area compared to Series 2 (Fig 4). Weak low level flow convergence is generally diagnosed from Series 1 – 2 forecasts for cases where soil moisture in Series 1 < Series 2 (not shown).

3. Potential predictability and skill

Potential predictability is defined here as the average explained variance (R^2) between a given ensemble member and any of the other members. The difference in potential predictability between Series 1 and Series 2 depicts the degree to which soil moisture helps improving potential predictability (Fig 5).

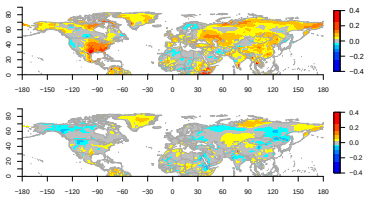


Figure 5: Difference in Series 1 – 2 potential predictability of JJA 10-day mean T2m for 1st (top) and 2nd (bottom) month after initialization.

The actual forecast skill improvement for 2000 – 2010 T2m in JJA (Fig 6) shows positive values in most Northern hemisphere areas in the first month, but no clear improvement in the second month of the forecasts.

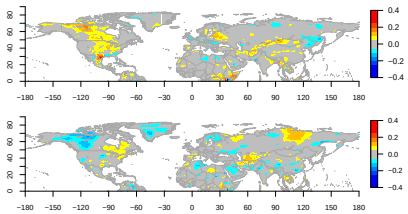


Figure 6: Series 1 – 2 difference in JJA 10-day mean T2m forecast skill relative to ERAint for forecasts in 1st (top) and 2nd (bottom) month after initialization.

4. Conclusion

The realistic soil initialization (Series 1) improves simulated temperature anomalies in e.g. the Russian heatwave event. A weak surface heat low is induced, but no systematic effect on blockings. Potential predictability gain at short lead times is considerable, with marginal improvements of short term T2m forecasts.